

Diesel Systems **Environmental world leader for clean mobility**



BOSCH

Invented for life

Clean Diesel Power



Clean Diesel Power

125  Bosch
Years 1886-2011

More technology invented for life to combat climate change

“At an early stage we conceived our motor-vehicle technology as technology for environmental protection.”

Franz Fehrenbach,
Chairman of the Board of Management
of Robert Bosch GmbH

For decades the increasing energy and mobility requirements of the human race have been leaving their mark on the global climate. In its world climate report published in 2007, the United Nations writes of the responsibility of mankind for global warming, warning in this context of the need for the sustainable management of our natural resources.

Experts like Nicholas Stern, former chief economist at the World Bank, also point out that the worldwide economic performance of the coming years and decades will depend to a great extent on the efforts we make to establish efficient climate protection.

Alongside further increases in anthropogenic CO₂ generation, the automobile industry must also take on a great responsibility to develop measures to combat climate change. As the largest supplier of automobile components, we are working together with vehicle manufacturers to find answers and solutions for mobility in a globalized world. In a world where billions of people, in China or India for instance, are entitled to claim for themselves the right to live at the same standard of mobility as the citizens of Europe or of the United States.

Climate protection needs innovations

The main task which we have to accomplish is to answer the question of how we can significantly improve energy efficiency in order to reduce CO₂ output to an even greater extent than we have managed to do over the past thirty years.

Today, as in the past, our company focuses on technology as our main field of effort.

From our point of view, long-term climate protection calls not for less technology but for more and better technology. Or, to put it differently: it will all depend on innovation.

Ecological challenges and economic opportunities

With our technologies and our know-how we have the ability to take over a pioneering role worldwide for efficient long-term climate protection. Thus ecological globalization also provides a great economic opportunity for the entire sector.

Let us work together to find new solutions – for clean mobility, worldwide!



When diesel goes in, clean stuff comes out

“Drivers of diesel vehicles will continue to be able to save money in future.”

Dr. Bernd Bohr, Chairman of the
Automotive Technology Division of
Robert Bosch GmbH



The automobile industry has achieved great things over the past few years. While the number of passenger cars between 1990 and 2007 rose by almost 52 percent and the number of commercial vehicles by at least 84 percent, the total CO₂ output of all vehicles in 2007 sank below the 1990 value – even in the case of, or mainly because of modern diesel engines. In other sectors such as energy generation, private households or commerce and trade, CO₂ output increased during this period.

Combustion engines have a future

Quite apart from climate protection, the finite nature of our oil reserves is an important driver for greater fuel efficiency. We are convinced that the internal combustion engine – in spite of all alternatives – will remain the dominant drive unit over the next 20 years. Not least because it still has considerable savings potential. And it is essential to exploit this potential at very short notice because in Asia and in America as well as in Europe, legislation on the reduction of CO₂ output has taken very concrete forms.

“Three-liter” cars in the compact class

We consider it realistic that in a few years time a 100 kW diesel engine can be produced for the compact class that will only burn 3 liters of fuel for every 100 km traveled (so-called “three-liter” vehicles), emitting less than 100 grams of CO₂ per kilometer. The cost of the extra diesel technology involved will pay for itself within three years at most. In the lower vehicle-class segments we are even assuming that it will be possible to meet future exhaust-gas standards without additional costs.

Diesels are good value

Even today it is technically possible for us to fulfill the strict regulations of the Euro 6 standard that will probably come into force in 2014. By comparison with a technically comparable gasoline vehicle, a diesel car today consumes over 30 percent less fuel, emits in consequence of this around 25 percent less CO₂ and has about 40 percent more range. In addition, the diesel has a torque that is some 50 percent higher. And contrary to a commonly-held belief, diesel vehicles can be often a more economical choice even with low driving distance per year.

Check it out at: www.fuel-pilot.com

We share a child's delight in every new idea.
And have done for 80 years.

"The award of the German Future Prize in 2005 by the President of the Federal Republic for our fuel-saving piezo-injection technology confirms our commitment to clean mobility."

Dr. Gerhard Turner, Chairman of the Diesel Systems Board of Management of Robert Bosch GmbH



What began in 1927 with the first diesel injection system, thus enabling diesel engines to be used in passenger cars, was continued without a break in the years and decades that followed. The name Bosch is linked with all important developments in diesel technology for passenger cars, commercial vehicles and large diesel engines. What we can offer for diesels today is unique anywhere in the world – particularly because we are not just now jumping onto the already-moving bandwagon of “climate protection” but have already been working for decades to make diesels ever cleaner.

This approach calls for the system competence that we have acquired over decades. A competence that is as beneficial to us as our unbroken preparedness to make heavy advance investments in the development of complex solutions and the opportunities for economically realizing these developments worldwide in large-series production.

45% of our patents aim at conserving the environment and resources Innovations do not come about by chance. They are born in the creative brains of our colleagues. And the rea-

son why Bosch produces so many of them is because we continuously invest, with great decision, more money in research and development than any other market participant: in 2008 we invested 3.25 billion Euro in our Automotive Technology division alone – this corresponds to some 12 percent of turnover. Throughout the entire Bosch Group, our applications resulted in some 3,850 patents of which around 45 percent were exclusively aimed at conserving the environment and natural resources.

Our contribution is recognized

Since 1990, WWF Deutschland together with the magazine Capital has awarded an “Eco-manager of the Year” prize. In 2006 the chairman of the Bosch board of management, Franz Fehrenbach, was the first representative of the automobile industry to be so honored. And recently Franz Fehrenbach was awarded a “Yellow Angel” from the German motoring organization ADAC for “ecological innovative strength”. For us these awards are a good reason to feel proud. They are also proof that our contribution toward more climate protection is recognized – and indeed appreciated. **At the same time this spurs us on to master the challenges of the future – with Bosch technology invented for life.**

Think in broader perspectives for better solutions



Common Rail Systems from Bosch are standard equipment in every modern diesel vehicle today. The high fuel-injection pressures of the piezo or solenoid-valve-controlled Common Rail injectors ensure clean, economical, quiet-running and powerful diesel engines. We have a system to suit every class of vehicle and every character of car.

CRS – three letters for every standard

In emerging markets, the new, compact Common Rail Systems of the CRS1 series are of special interest for compact and small cars. They fulfill emission standards corresponding more or less to Europe's Euro 4. It is already possible to design systems of the CRS2 series with solenoid-valve injectors, which are mainly installed in mid-range vehicles and operate with multiple injections with short intervals between each injection at pressures of up to 2,000 bar, to meet the demands of Euro 6. This also applies to diesel systems in the top segment: systems from the CRS3 series for engines with up to 12 cylinders and achieving a high specific performance with maximum injection pressures of up to 2,500 bar.

Cutting CO₂ output even further

With the Common Rail Systems from Bosch and further developments in turbocharging we can realize downsizing concepts which permit a 100 kilowatt diesel engine emitting less than 100 grams of CO₂ per kilometer. For the next few years we predict an overall reduction in fuel consumption and thus of CO₂ output of up to one third. This is made possible by the following ideas and solutions, among others:

- ▶ Our Start/Stop Systems save up to 8 percent of fuel in urban traffic
- ▶ Braking-energy recuperation with optimized generators can achieve up to 3 percent lower fuel consumption
- ▶ Intelligent management of the vehicle's electrical system can save 2 percent
- ▶ Better thermal management matches the cooling performance of the engine cooling system to the operating state and thus makes electrical load savings of up to 4 percent
- ▶ Optimized transmission-matching leads to lower frictional losses in the engine and can significantly reduce fuel consumption

Economically ecological.
Ecologically economical.



The most important consideration in commercial-vehicle operation is running costs. We at Bosch know that for hauliers or fleet operators every cent saved per kilometer is quite literally worth thousands and often even millions below the line.

Economical, low-consumption engines are an important factor in these financial calculations. But their efficient operation is also the basis for low-emission driving with reduced CO₂ output, thus contributing toward adherence to worldwide emission limits and standards.

Light, medium and heavy duty

Alongside our existing injection systems we offer ever higher injection pressures and greater freedom in the design of the injection rate particularly in combination with the latest Common Rail generations. Here we offer an extensive portfolio of system versions for every kind of commercial-vehicle diesel engine – whether this is the low-cost and sturdy CRS2.2 for light-duty vehicles, the evolutionary further development CRSN3.3 for medium and heavy vehicles, or the high-performance CRSN4.2 for heavy-duty requirements.

Intelligent and rapid solutions

Customers of vehicle manufacturers who put their trust in components and systems from Bosch benefit from the rapid and precise diagnostics capability of our products and thus from the fact that their vehicles do not spend very long in the workshop and are simple to repair. In general, downtime for maintenance or repair seldom exceeds one day. This is ensured by the “Bosch eXchange Program” using refurbished parts available at our Service Centers and ready for immediate fitting – all over the world and throughout the vehicle’s entire life! The Bosch eXchange Program enables annual savings of around 500 tonnes of steel, 180 tonnes of aluminum and 2750 tonnes of CO₂ to be made.

From our point of view this is an intelligent and resource-friendly program that also has a positive effect on the total costs of ownership, thus also influencing the operator’s financial calculations.

As well as saving fuel, intelligent solutions from Bosch help to unite ecology and economy, to the benefit of both!

Always the right dose of
regeneration.



Departronic Injection Unit
(left) and Metering Unit

An interesting experiment carried out in 2004 by the Cancer Institute in Milan came to the following conclusion: a modern 2-liter diesel engine running idle for 100 minutes generates approximately the same amount of particulate as a burning cigarette. This example is not intended to suggest harmlessness but, rather, to demonstrate the high technical level which vehicle manufacturers and component suppliers have already reached today.

Already available in the late 1990s: diesel particulate-filter systems from Bosch

Today a large number of diesel vehicles make use of the engine-management system developed by Bosch as well as the sensor system to operate the particulate filter.

Differential-pressure sensors and intelligent software simulations identify the charge state of the particulate filter. This information allows the regeneration of the filter to be carried out as needed. This saves fuel by comparison with regeneration at fixed intervals and always ensures ideal filter performance.

Departronic enables efficient thermal regeneration

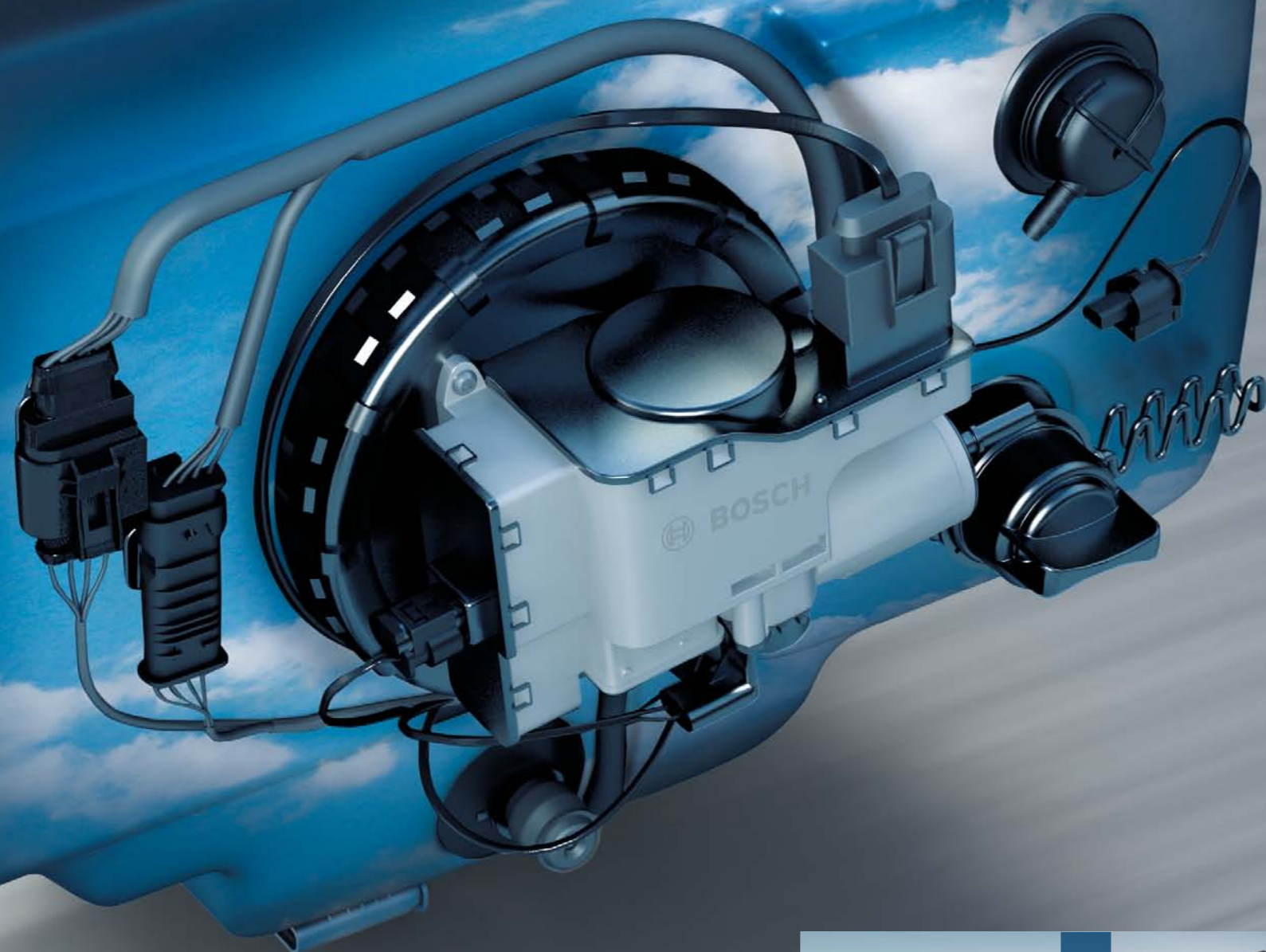
Bosch developed Departronic to reliably regenerate the particulate filter in commercial vehicles. Therefore temperatures of around 600°C in the particulate filter are required. These temperatures could be achieved via internal engine measures alone. This can, however, lead to a dilution of the engine oil and reduced oil-change intervals.

Benefits of Departronic

Via the targeted injection of diesel fuel into the exhaust gas, Departronic helps to massively reduce the need for internal engine measures or even avoid the need for such measures. The ideal adaption of the injection timing and quantity increases the efficiency of active regeneration and thus saves fuel. Furthermore the Bosch Departronic is robust and maintenance-free. It allows longer oil-change intervals compared to internal engine measures.

The Bosch Departronic can be universally combined with every diesel fuel injection system for commercial vehicles.

Turning nitrogen oxides into harmless water vapor



Denoxtronic 3.1 for passenger cars and light duty vehicles

Denoxtronic 2.2 for commercial vehicles. Dosing Module (left) and Supply Module



Staying below the world's strictest limits for nitrous-oxide emissions will, in future, only be possible by the use of efficient exhaust-gas treatment systems. With our Denoxtronic for commercial vehicles we have already been offering such a system on the market with great success since 2004. In the meantime, this system is also being successfully used in off-highway applications.

Up to 95 percent lower NO_x emissions

The Denoxtronic injects the reduction agent "AdBlue/DEF" (a 32.5-percent solution of urea in water) directly into the flow of exhaust gas upstream of the SCR (Selective Catalytic Reduction) converter. It is there that the urea produces the ammonia required for the next reaction. At the second stage the ammonia in the SCR catalytic converter reduces the nitrous oxides from the exhaust gas into harmless water vapor and nitrogen. The metering control unit, which is networked with the engine electronics, matches the dosing of "AdBlue/DEF" precisely to the relevant engine parameters. It is thus possible to reduce NO_x emissions by up to 95 percent and to improve the efficiency of the diesel engine by around 3 percent.

One system, two versions

We have used our experience with the Denoxtronic for commercial vehicles, which has proved its worth for many years in tough long-distance operation, to develop a system for passenger cars and light duty vehicles. And here we have been very successful, too. In 2008 Bosch was awarded the "EcoGlobe" environmental prize in the category "Supplier innovations".

Diesel passenger cars fitted with Denoxtronic are already available on the European and the US markets. It will, incidentally, be possible to improve the efficiency of a diesel engine fitted with this exhaust-gas treatment system even further.

Engineering services

We are always pleased to pass on our systems know-how to our customers. That is why we offer them a wide range of engineering services for development, application and vehicle tests at every stage in a vehicle's development.

We are at your disposal as a competent partner for complete diesel systems – worldwide!

Robert Bosch GmbH

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In 2011, the Bosch Group is celebrating a double anniversary: the 125th anniversary of the company's establishment, and the company founder's 150th birthday. This is cause for more than mere retrospection – it prompts us to show how the company's past fuels its future. The history of the company has had its ups and downs, but at the same time has always been vibrant. We see this history as one that drives us forward to new – and above all beneficial – achievements.

